Space Weather Technical Forecast

Issued on Friday, 24 May 2024 at 00:24 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: R1 Likely throughout. Slight Chance G1 Saturday 25 May.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity has been Moderate at GOES16, with occasional M-class flares observed. All of these emanated from AR3679 in the southwest quadrant, peaking with an impulsive M4.2 at 23/0216UTC.
AR3679 is one of five numbered sunspot regions on the current disc, with two other small and simple unnumbered regions, one of which has recently rotated onto the northeast limb. Changes in the sunspot groups were generally small through the period, however the exceptions were AR3679 and AR3685, both in the southwest. AR3679 saw emergence and spreading of new central penumbral spots to become a compact group, an Ekc/Beta-Gamma-Delta. AR3685 is now a beta-gamma, having recently simplified from the previous beta-gamma-delta configuration, but remains a region of note because of its current classification of Ehi/beta-gamma.

The period has been notably active in terms of Coronal Mass Ejections (CMEs). The first CME was from a very large partial filament lift off near 30 East, with the centroid difficult to determine, but producing a filament channel-like signature in AIA304 near 30S around 23/0100UTC. This in turn helped trigger a second event near S25E020 around 23/0600UTC, which may have lead to a more central filament eruption at 23/0630UTC, with this final event clear on AIA304 and H-Alpha imagery. Since then further CME's have emerged, one large CME linked to a long duration M2 flare form AR3679 around 23/1330 UTC and another smaller CME that appears to be from a region approaching the east limb from the far side.
Despite all of these CME's currently none are forecast to be Earth directed. However, further analysis will be on-going, especially as the last of the filament eruptions was almost centre disc.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 have been indicative of ongoing slow wind conditions.

The solar wind speed was steady at background levels between 360 to 400km/s, with the solar wind density predominantly below average in single-figures ppcc. The IMF was generally weak, but did occasionally reach Moderate levels through the day and peaked at 10nT at 23/2307 UTC. The north-south component was initially positive but soon changed to become mostly negative, reaching -8 nT in the evening. The phi angle was predominantly positive (away from the Sun).

The net result of the above solar wind measures was Quiet to Unsettled (Kp 1-3) geomagnetic conditions increasing to Active (Kp 4) at the end of the day.

Energetic Particles / Solar Radiation: High energy proton flux at GOES18 (greater than 10 MeV) remained at Background levels.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

High energy electron flux (greater than 2MeV) observed by GOES16 was mainly Moderate, with a broad peak of 480 pfu at 23/1725 UTC. The associated 24-hour fluence has remained below the Active threshold, but with an increasing trend. Observed fluence at 24/0001UTC was 1.22e7 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is likely to continue, with isolated M-class flares possible each day, and a Slight Chance of rising to High due to any X-class flares. These are most likely from AR3679, but Ex-AR3663 and Ex-AR3666 are also anticipated to return to the northeast limb within the next 24 to 36 hours. However, it is uncertain how much of these regions have survived their transit across the far-side and the overall risk of significant flares gradually reduces over the four-day period as a result.

Solar Wind / Geomagnetic Activity: Currently there are no Earth-directed CMEs expected. Background to Slightly Elevated solar winds are expected for much of the forecast period, but with a potential onset of a fast wind enhancement from the southward extension of northern hemisphere CH39/- from late tomorrow (25th) into day 3 (26th). Late on day 4 (27th) a HSS from CH40 may become geoeffective. The solar winds may reach Elevated levels with both potential solar wind enhancements. There is a Slight Chance of G1/Minor geomagnetic storm (Kp 5) intervals being reached, most likely Saturday 25th May. Otherwise geomagnetic activity is expected to be mainly Quiet to Unsettled (Kp 1-3), but increasing Active (Kp 4) at times, mainly tomorrow (25th) and perhaps again late day 4 (27th).

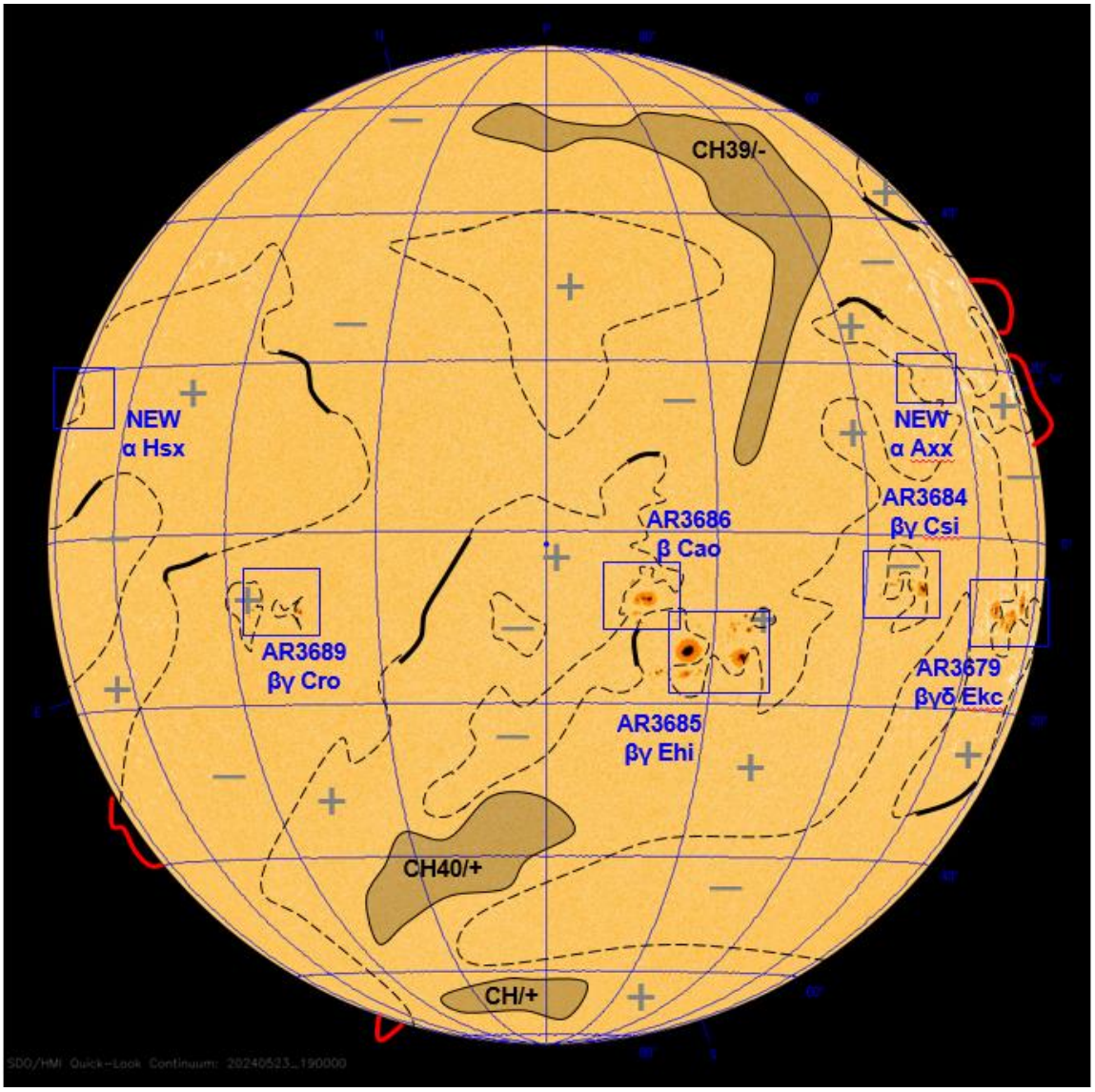
Energetic Particles / Solar Radiation: High energy proton flux carries a daily Slight Chance of enhancement should any Moderate or Strong flares materialise. The chance of this occurring is expected to gradually reduce later in the forecast period as the larger spot groups reach the far side and rotate further away from the west limb.

High energy electron flux is forecast to remain at Normal Background to Moderate levels initially, perhaps declining to mainly background levels with any fast wind arrival, before probably starting to recover with a gradual increase again later in the period. The corresponding fluence is expected to remain well below the Active threshold (1e8 integrated flux), despite a gradual rising trend through today and again later in the period.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 1. Solar Analysis Valid 23/1900 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Geomagnetic Storms:

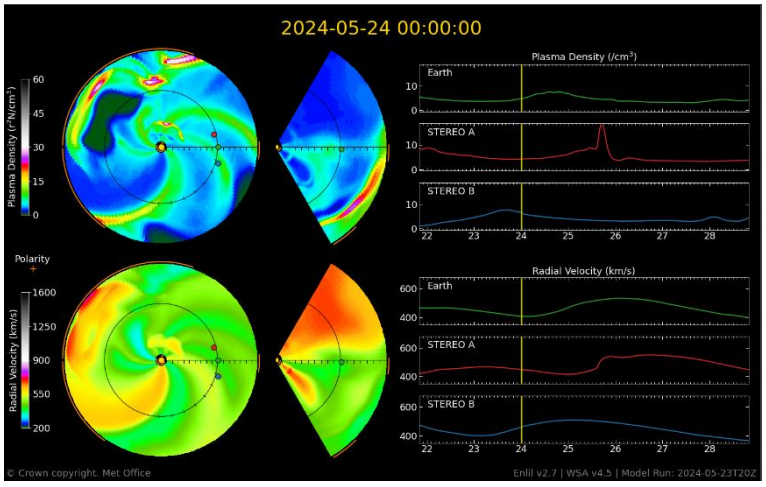
Currently there are no Earth-directed CMEs expected, although further analysis will be undertaken of the CME's observed so far.

Slightly Elevated solar winds are expected to persist today (24th May), before the onset of any fast wind enhancement from the southward extension of northern hemisphere CH39/-. This is a large northern hemisphere feature, with a narrow southern extension into the solar mid-latitudes, and was not present on the previous rotation. Late on day 4 (27th) a new HSS may arrive from CH40 in the southern hemisphere. Coupled with the un-favoured time of year for strong connections to coronal hole fast winds (Russel-McPherron effect), and the limited response currently featured in the MOSWOC Enlil model, a significant geomagnetic response is considered unlikely from any high speed stream arrival.
Either fast wind enhancement is likely to reach roughly 450-500km/s. Active geomagnetic intervals are possible, mainly from late today (Friday 24 May) and through tomorrow, and again late on day 4 (27th). There is a Slight Chance of G1/Minor geomagnetic storms (Kp 5) intervals through Saturday 25 May.

Quiet to Unsettled conditions (Kp 1-3) should otherwise start and end the forecast period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	5	10	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

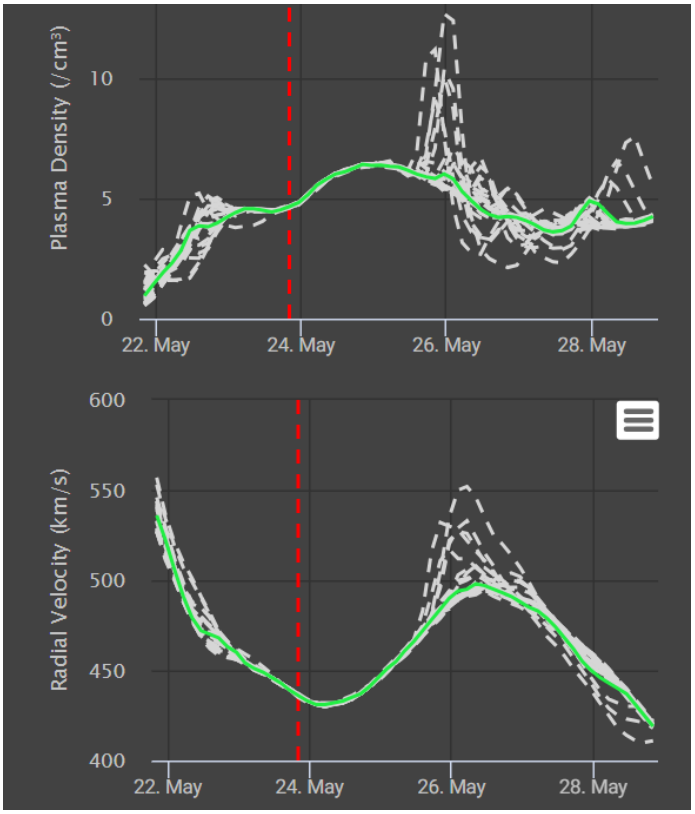
Figure 2: Met Office Enlil model.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Figure 3: Met Office Enlil ensembles indicating possible glancing blows from CME's from late day 2 (25th).



Radio Blackouts - X-Ray Flares:

There are currently five sunspot numbered regions on the disc, with two unnumbered regions including one small and simple region that has rotated onto the northeast limb. Changes in the sunspot groups were generally small through the period, except for AR3685 which simplified to become beta-gamma, with the disappearance of its previous Mt Wilson delta spot. AR3679 in the southwest remains the most significant region due to its size and magnetic complexity. Ex-AR3663 and Ex-AR3666 may return over the northeastern limb within the next 24-36 hours. However, it is uncertain how much of these regions have survived their transit across the far-side. A more assured far-sided survival from recent halo CME evidence is Ex-AR3664, which is the large G5-producing sunspot region of 10-11 May. This is due to return just outside the current range of the forecast.

The majority of solar activity has emanated from AR3679, but this region will rotate off to the far side later day 2 (25th). Therefore the daily flare risk is showing a gradual reduction in probabilities, although this trend may be revised once the returning regions arrive. Overall Moderate activity is expected to continue with further isolated M-flares, and a slight chance of an isolated X-class flare.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	60	55	50	50
Very Active	R3 to R5 X Class	No	10	5	5	1

Solar Radiation Storms - (High Energy Protons):

High energy proton flux carries a daily Slight Chance of breaching the S1 threshold, largely due to the present of AR3679 approaching the southwest limb, with a minor contribution from the now-departed Ex-AR3674. There has been no recent history of proton enhancements from any group, however the risk is still felt to peak today and tomorrow, after which the risk declines as AR3679 rotates onto the far-side.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	20	20	15	10
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

High Energy Electrons Event (≥ 2MeV):

Currently no Earth-bound CMEs are expected to arrive, and therefore influence the electron forecast at GEO. Therefore influence over high energy electrons levels will be solely due to coronal hole high speed stream influence. The main driver of geomagnetic activity and arising electron response is therefore the non-persistent CH39/-. Being a new feature, confidence in the forecast fluence is lower than is typical, but it does benefit from a relatively unimpeded CME outlook.

Overall there is a Slight Chance of eventual Active 24-hour integrated fluence resulting from the fast wind, although the portion of CH39/- near the solar equator appears weak and we are nearing the less potent part of the semi-annual cycle (i.e. we are relatively nearer the muted solstice rather than the equinoxes).

Despite the lack of persistence to aid MOSWOC REFM the model is considered to be offering reasonable guidance, keeping the fluence well below the Active threshold with a rising trend through today and again, at lower levels, later in the period.

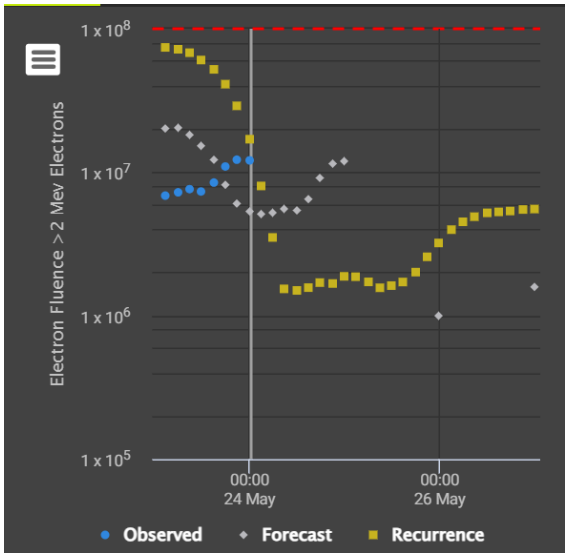
GEO Electron Environment	Level (cm^{-2} sr^{-1}	Past 24 Hours	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.

Probability (Exceedance)	day^{-1})	(Yes/No)	(%)	(%)	(%)	(%)
Active	**≥ 2 MeV ≥ 1x10^{8}**	No	5	1	10	20
Very Active	**≥ 2 MeV ≥ 1x10^{9}**	No	1	1	1	1

Figure 4: Met Office REFM model.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 330 135 4254 Email: moswoc@metoffice.gov.uk

© Crown Copyright 2024. All Rights Reserved.